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Economic Impact of Implementing RACT (Reasonably Available Control Tecnology) Guidelines in the Non-Attainment Areas for Ozone in North Carolina

Booz-Allen and Hamilton, Inc, Florham Park, NJ

Prepared for

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16. ABSTRACT

The major objective of the contract effort was to determine the direct economic impact of implementing RACT standards in North Carolina The study is to be used primarily to assist EPA and state decisions on achieving the emission limitations of the RACT standards.

The economic impact was assessed for the following 2 RACT industrial categories: surface coating of paper and bulk gasoline terminals.

The scope of this project was to determine the costs and direct impact of control to achieve RACT guideline limitations in the nonattainment areas of North Carolina. Direct economic costs and benefits from the implementation of RACT limitations were identified and quantified while secondary impacts (social, energy, employment, etc.) are addressed, they were not a major emphasis in the study.

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FINAL REPORT

ECONOMIC IMPACT OF IMPLEMENTING RACT GUIDELINES IN THE NONATTAINMENT AREAS FOR OZONE IN NORTH CAROLINA

TASK ORDER NUMBER 6 UNDER:

Basic Ordering Number 68-02-2544

RESEARCH AND DEVELOPMENT SERVICES FOR ASSISTANCE TO STATES AND EPA CARRYING OUT REQUIREMENTS OF CLEAN AIR ACT AND APPLICABLE FEDERAL AND STATE REGULATIONS

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV
AIR & HAZARDOUS MATERIALS DIVISION
ATLANTA, GEORGIA 30308

EPA PROJECT OFFICER: Winston Smith

From:

BOOZ, ALLEN & HAMILTON Inc.

March, 1979

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This report was furnished to the EPA by Booz, Allen & Hamilton Inc. in fulfillment of Task Order Number 6 of Basic Ordering Agreement Number 68-02-2544. This report has been reviewed by EPA Region IV and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the EPA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

TABLE OF CONTENTS

CHAPTER	TITLE
1.0	EXECUTIVE SUMMARY
2.0	INTRODUCTION AND OVERALL STUDY APPROACH
5.0	THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING PAPER IN MECKLENBURG COUNTY
13.0	THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY

LIST OF EXHIBITS

Exhibit		Following Page
1-1	LISTING OF EMISSION LIMITATIONS THAT REPRESENT THE PRESUMPTIVE NORM TO BE ACHIEVED THROUGH APPLICATION OF RACT FOR TWO INDUSTRY CATEGORIES	1-3
1-2	SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR PAPER COATERS IN MECKLENBURG COUNTY IN THE STATE OF NORTH CAROLINA	1-7
1-3	SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY	1-7
1-4	SUMMARY OF IMPACT OF IMPLEMENTING RACT GUIDELINES IN 2 INDUSTRIAL CATEGORIES NON-ATTAINMENT AREAS OF NORTH CAROLINA	1-8
2-1	LISTING OF EMISSION LIMITATIONS THAT REPRESENT THE PRESUMPTIVE NORM TO BE ACHIEVED THROUGH APPLICATION OF RACT FOR FIFTEEN INDUSTRY CATEGORIES	2-4
5-1	DATA QUALITY--SURFACE COATING OF PAPER	5-5
5-2	1976 INDUSTRY STATISTICS--SURFACE COATING OF PAPER SIC GROUPS IN NORTH CAROLINA	5-6
5-3	COMPANIES COATING PAPER IN MECKLENBURG COUNTY	5-6
5-4	HISTORICAL TRENDS IN VALUE OF SHIPMENTS OF U.S. PLANTS ENGAGED IN PAPER COATING ($ MILLIONS)	5-6
5-5	EMISSION DATA FROM TYPICAL PAPER COATING PLANTS	5-8
5-6	VOC EMISSIONS FROM PAPER COATING FACILITIES IN MECKLENBURG COUNTY IN 1977	5-10
5-7	ACHIEVABLE SOLVENT REDUCTIONS USING LOW SOLVENT COATINGS IN PAPER COATING INDUSTRY	5-11

Exhibit		Following Page
5-8	SUMMARY OF ASSUMPTIONS USED IN COST ESTIMATE	5-16
5-9	SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR PAPER COATERS IN MECKLENBURG COUNTY IN THE STATE OF NORTH CAROLINA	5-20
13-1	DATA QUALITY	13-3
13-2	INDUSTRY STATISTICS FOR BULK TERMINALS IN MECKLENBURG COUNTY	13-5
13-3	GASOLINE DISTRIBUTION NETWORK	13-5
13-4	BOC EMISSION CONTROL TECHNOLOGY FOR TANK TRUCK GASOLINE LOADING TERMINALS	13-8
13-5	DEFINITION OF MODEL TANK TRUCK GASOLINE LOADING TERMINALS	13-10
13-6	ESTIMATED COST OF VOC CONTROL FOR MODEL TANK TRUCK GASOLINE LOADING TERMINALS	13-10
13-7	COSTS OF VAPOR CONTROL SYSTEMS FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY	13-11
13-8	SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY	13-14

1.0 EXECUTIVE SUMMARY

1.0 EXECUTIVE SUMMARY

This chapter summarizes the major elements and most significant findings of this study to determine the economic impact of implementing Reasonably Available Control Technology (RACT) guidelines for volatile organic compounds for two industrial categories in the non-attainment areas of North Carolina. Mecklenburg County currently is the only area designated as "non-attainment" in North Carolina. Further discussion and data are presented in detail in the subsequent chapters of the report. This Executive Summary is divided into two sections:

- Objectives, Scope and Approach
- Economic Implications of Each RACT Guideline and Non-Attainment Area Aggregate

1.1 OBJECTIVES, SCOPE AND APPROACH

The Clean Air Act Amendments of 1977 required the states to revise their State Implementation Plans (SIPs) to provide for the attainment and maintenance of national ambient air quality standards in areas designated as nonattainment. The Amendments require that each state submit the SIP revisions to the U.S. Environmental Protection Agency (EPA) by January 1, 1979. These proposed regulations should contain an oxidant plan submission for major urban areas to reflect the application of Reasonably Available Control Technology (RACT) to stationary sources for which the EPA has published guidelines. The Amendments also require that the states identify and analyze the air quality, health, welfare, economic, energy and social effects of the plan provisions.

1.1.1 Objectives

The major objective of the contract effort was to assist the states in the determination of the direct economic impact of selected segments of their SIPs for six states (Alabama, Georgia, Kentucky, North Carolina, South Carolina and Tennessee) of Region IV of the U.S. Environmental Protection Agency. These studies will be used primarily to assist EPA and state decisions on achieving emission limitations.

1.1.2 Scope

The scope of this project for North Carolina was to determine the costs and direct impacts of control to achieve RACT guideline limitations in two industrial categories in Mecklenburg County. The impact was addressed for each industry and for each state so that the respective studies are applicable to individual state regulations. Direct economic costs and benefits from the implementation of the RACT guidelines were identified and quantified. While secondary (energy, employment, etc.) impacts were addressed, they were not a major emphasis in the study. In summary, direct economic impact analysis of each industrial category was aggregated on a statewide basis (for North Carolina, only one county is designated as non-attainment for ozone, therefore the analysis was aggregated county-wide) for the RACT categories studied.

In North Carolina, the economic impact was analyzed for the implementation of RACT guidelines for the following industry categories:[1]

- Surface coating of paper
- Bulk gasoline terminals

The major study guidelines in the determination of the economic impact of the RACT guidelines are discussed below.

- Emissions sources included were existing stationary point sources in the applicable industrial categories with potential VOC emissions greater than 100 tons in Mecklenburg County, which is classified an nonattainment for ozone. This study does not address the economic impact of implementing RACT guidelines in other areas of North Carolina.

- The emission limitations for each industrial category were studied at the control level established by the RACT guidelines. These are presented in Exhibit 1-1, on the following page.

- All costs and emission data were presented for 1977.

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1. In a preliminary draft report, Booz, Allen had studied 10 RACT categories including the following: metal cans, fabrics, metal furniture, large applicances, solvent metal cleaning, bulk gasoline plants, service stations, and use of cutback asphalt as well as the two listed above. The report included sources with emissions greater than 3 pounds per hour or 15 pounds per day in Mecklenburg County and sources with potential emissions of 100 tons or more in other areas of the state. This final report is adopted to proposed changes in the state regulations.

EXHIBIT 1-1
U.S. Environmental Protection Agency
LISTING OF EMISSION LIMITATIONS THAT REPRESENT
THE PRESUMPTIVE NORM TO BE ACHIEVED THROUGH
APPLICATION OF RACT FOR TWO INDUSTRY CATEGORIES

Category	RACT Guideline Emission Limitations[a] Surface Coating Categories Based on Low Organic Solvent Coatings (lbs. solvent per gallon of coating, minus water)
Surface Coating of Paper	2.9
Bulk Gasoline Terminals	Vapor control system may not allow mass emissions of VOC from control equipment to exceed 80 milligrams per liter (4.7 grains per gallon) of gasoline loaded.

a. Annotated description of RACT guidelines.

Source: Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, U.S. Environmental Protection Agency, EPA-90512-78-001, April 1978.

- The following volatile organic compounds were exempted:

  - Methane
  - Ethane
  - Trichlorotrifluorethane
  - 1,1,1-trichloroethane (methyl chloroform).[1]

- The timing requirement for implementation of controls to meet RACT emission limitations was May 1, 1980 for cutback asphalt and May 1, 1982 for the other industry categories.

1.1.3 Approach

The approach applied to the overall study was: a study team with technology and economic backgrounds utilized available secondary sources to estimate the emissions, statistics and costs for each RACT industrial category; then, the study team completed, calibrated and refined these estimates based on interviews with industry representatives in the state.

For the two RACT industrial categories studied (surface coating of paper and bulk gasoline terminals), the potentially affected facilities, emissions and emission characteristics were obtained primarily from the North Carolina Department of National Resources and Community Development. Therefore, the following generalized methodology was applied:

- A list of potentially affected facilities was compiled from secondary reference sources.

- Data from the North Carolina emission inventory were categorized and compiled for each RACT industrial category.

- Firms not listed in the emission inventory were identified. Some of these facilities were then contacted by telephone when there was doubt concerning their inclusion.

- Emissions, emission characteristics, control options and control costs were studied for relevant firms.

- Interviews were conducted to determine applicable control options and potential control costs.

- The study team then evaluated the control cost to meet the RACT requirements and the potential emission reduction.

1.1.4 Quality of Estimates

The quality of the estimates that are presented in this report can be judged by evaluating the basis for estimates of the individual study components. In each of the chapters that deal with the development of estimated compliance cost, the sources of information are fully documented. In addition, the study team has categorically ranked by qualitative judgment the overall data quality of the major sources and, therefore, of the outcomes. These data quality estimates were ranked into three categories:

- High quality ("hard data")--study inputs with variation of not more than $\pm$ 25 percent
- Medium quality ("extrapolated data")--study inputs with variation of $\pm$ 25 to 75 percent
- Low quality ("rough data")--study inputs with variation of $\pm$ 50 to 150 percent.

Each of these data quality estimates is presented in the individual chapters. The overall quality ranking of the study inputs for each RACT industrial category was generally in the medium quality range.

1.2 ECONOMIC IMPLICATIONS OF EACH RACT GUIDELINE AND NONATTAINMENT AREA AGGREGATE

1.2 ECONOMIC IMPLICATIONS OF EACH RACT GUIDELINE AND NONATTAINMENT AREA AGGREGATE

This section presents a summary of the economic impact for the two RACT categories studied in North Carolina.

The scope of this study is limited because of the applicability of the proposed VOC regulations:

- There is only area classified as nonattainment for ozone in North Carolina -- Mecklenburg County.
- The proposed regulations apply only to sources with potential VOC emissions of 100 tons per year or greater.

After a review of the potentially affected facilities in Mecklenburg County, it was determined that facilities in three RACT categories would be applicable to the proposed regulations (potential emissions greater than 100 tons annually). These categories were surface coating of paper, surface coating of fabrics and bulk gasoline terminals. Only one facility was potentially affected by the surface coating of fabrics RACT guideline, therefore, it was determined that surface coating of fabrics should not be included in this economic impact study. Although the cost impact might be significant for the individual fabric coating firm excluded, it is unlikely that the economic or energy impact would be significant at the macrolevel (statewide).

1.2.1 Surface Coating of Paper

This study covered two plants in Mecklenburg identified from the RACT requirements for paper coaters. Excluded from this study are facilities engaged in publishing, who may coat paper as a segment of the processing line. The study assumes that these facilities would fall under other RACT guidelines currently being developed, such as Graphic Arts. Further definition of the paper coating category should be established prior to enforcement.

The retrofit situations and installation costs for add-on control are highly variable. Based on these variations, the estimated capital cost to these two plants is between $1.5 million and $1.9 million, with an annualized cost of $0.35 million to $0.5 million (approximately 1.3 percent of the statewide value of shipments). Nationwide some dislocation in the paper coating industry may occur unless more cost-effective means of control (such as waterbased coatings) can be applied.

Assuming 35 percent heat recovery, the annual energy requirements are expected to increase by approximately 1,200 equivalent barrels of oil per year. Energy consumption may decrease if further efficient recovery of incinerator heat is possible.

Incinerator equipment manufacturers have stated that there may be significant problems in meeting the anticipated demand for high heat reocvery incinerators on a nationwide basis.

Exhibit 1-2 on the following page presents highlights of the study findings which are presented in detail in Chapter 5 of the report.

1.2.2 Tank Truck Gasoline Loading Terminals

There are an estimated 14 terminal facilities in Mecklenburg County affected by the limitation requirements. Emission control of these facilities is expected to require a capital investment of $3.8 million. Product recovery of gasoline will be accrued only from bulk terminal emission control installations, and not from the potential recovery of vapors from service stations and bulk gasoline plants. The net annualized cost for implementation of RACT for bulk gasoline loading terminals is estimated to be $0.81 million.

No significant productivity, employment or market structure dislocations should be associated with implementing the RACT guidelines.

Exhibit 1-3 on the following page presents highlights of the study findings, which are presented in detail in Chapter 13 of the report.

1.2.3 Aggregate Economic Impact for the Two RACT Categories Studied

The implementation of RACT emission limitations for two industrial categories in Mecklenburg County of North Carolina involves an estimated $5.5 million capital cost and $1.2 million annualized cost per year. The net VOC emission reduction is estimated to be 3,456 tons annually from a 1977 baseline of 3,928 tons for these categories. Exhibit 1-4, on the following page, presents a quantitative summary of the emissions, estimated cost of control, cost indicators and cost effectiveness of implementing RACT guidelines for six industrial categories.

EXHIBIT 1-2(1)
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR PAPER COATERS
IN MECKLENBURG COUNTY
IN THE STATE OF NORTH CAROLINA

Current Situation	Discussion
Number of potentially affected facilities	Two plants are expected to be affected by these regulations. However, if this category were to be interpreted to include all types of paper coating, including publishing, far more firms would be affected.
Indication of relative importance of the industrial sector to the state economy	The 1977 value of shipments of these two plants is estimated to be about $33 million. They are estimated to employ 505 people.
Current industry technology trends	Gravure coating replacing older systems.
1977 VOC emissions (actual)	Approximately 881 tons per year from two plants affected by RACT.
Industry preferred method of VOC control to meet RACT guidelines	Though low solvent use is increasing, progress is slow. Add-on control systems will probably be used.
Assumed method of control to meet RACT guidelines	Thermal incineration with primary heat recovery and carbon adsorption.
Affected Areas in Meeting RACT	**Discussion**
Capital investment (countywide)	Estimated to be $1.5 million to $1.9 million depending on retrofit situations. This is likely to be more than 100 percent of normal expenditures for the affected paper coaters.
Annualized cost (countywide)	$0.35 million to $0.5 million annually. This represents 1.1 to 1.5 percent of the value of shipments for the two firms directly affected.
Price	Assuming a "direct cost pass-through"-- 1.1 to 1.5 percent at the two affected firms.

EXHIBIT 1-2(2)
U.S. Environmental Protection Agency

Affected Areas in Meeting RACT	Discussion
Energy	Assuming 35 percent heat recovery from the incineration system, annual energy requirements are expected to increase by approximately 1,200 equivalent barrels of oil.
Productivity	No major impact.
Employment	Marginal impact possible.
Market structure	Marginal impact possible.
RACT timing requirements (1982)	Equipment deliverables and installation of incineration systems prior to 1982 are expected to present problems. Development of low solvent systems is likely to extend beyond 1982.
Problem areas	RACT guideline needs clear definition for enforcement.
	Retrofit situations and installation costs are highly variable.
	Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after control	Approximately 167 tons/year (19 percent of 1977 VOC emission level from two affected plants).
Cost effectiveness of control	$490 - $700 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

Exhibit 1-3
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY

Current Situation	Discussion
Number of potentially affected facilities	14
Indication of relative importance of industrial section to state economy	1977 industry sales were $616 million. The estimated annual throughput was 1.45 billion gallons
Current industry technology trends	New terminals are currently being designed with vapor recovery equipment
1977 VOC actual emissions	3,048 tons per year
Industry preferred method of VOC control to meet RACT guidelines.	Submerge or bottom fill and vapor recovery

Affected Areas in Meeting RACT	Discussion
Capital investment (countywide)	$3.8 million
Annualized cost (countywide)	$0.81 million (approximately) 0.12 percent of value of shipment)
Price	Assuming a direct cost passthrough-$0.0005 per gallon
Energy	Assuming full recovery of gasoline-net savings of 19,200 barrels annually from terminal emissions
Productivity	No major impact
Employment	No direct impact
Market structure	No direct impact
VOC emission after control	305 tons per year
Cost effectiveness of control	$295 annualized cost/annual ton of VOC reduction from terminals assuming no gasoline credit from vapors potentially returned from bulk gasoline plants and gasoline service stations

Source: Booz, Allen & Hamilton Inc.

EXHIBIT 1-4
U.S. Environmental Protection Agency
SUMMARY OF IMPACT OF IMPLEMENTING RACT
GUIDELINES IN 2 INDUSTRIAL CATEGORIES -- NON-ATTAINMENT
AREAS OF NORTH CAROLINA

	Emissions				Cost of RACT Control		Cost Indicators		Cost Effectiveness
Industry Category	Number of Facilities Potentially Affected	1977 VOC Emissions (tons/yr.)	Estimated VOC Emissions After Implementing RACT (tons/yr.)	Net VOC Emission Reductions (tons/yr.)	Capital Cost[a] ($ millions)	Annualized Cost (Credit) ($ millions)	Annualized Cost as Percent of Value of Shipments[b] (percent)	Annualized Cost Per Unit Shipment (cost per unit)	Annualized Cost (credit) Per Ton of VOC Reduction ($ per tons/yr.)
Surface coating of paper	2	880	167	713	1.7	0.4	1.3	-	600
Tank truck gasoline	14	3,048	305	2,743	3.8	0.81	0.12	0.0005/gal.	295
TOTAL	16	3,928	472	3,456	5.5	1.2			

Note: Figures presented in this exhibit are rounded and approximated for comparison purposes.

a. Includes one time costs
b. Value of shipments represents the total value in the specific industry category.

Source: Booz, Allen & Hamilton Inc.

The implementation of the RACT guidelines for the two industrial categories is estimated to represent a net energy savings of 18,000 equivalent barrels of oil annually. Assuming a value of oil at $13 per barrel, this is an equivalent energy savings of $234,000 annually.

- RACT compliance requirements for bulk gasoline terminals represent a net energy savings of approximately 19,200 barrels of oil annually.

- RACT compliance requirement for surface coating of paper represents a net energy demand of approximately 1,200 equivalent barrels of oil annually.

* * *

The remaining chapters present details on the findings that are presented in the Executive Summary.

2.0 INTRODUCTION AND OVERALL STUDY APPROACH

2.0 INTRODUCTION AND OVERALL STUDY APPROACH

This chapter presents an overview of the study's purpose, scope and methodology. It is divided into six sections:

- Background
- Summary of State Implementation Plan revisions and state's need for assistance
- Scope
- Approach
- Quality of estimates
- Definition of terms used.

Each of these sections is discussed below.

The approach and quality of estimates is discussed in detail in each of the respective chapters dealing with the specific industrial categories affected by the volatile organic compounds control regulations.

2.1. BACKGROUND

The Clean Air Act Amendments of 1977 required the states to revise their State Implemtation Plans (SIPs) to provide for the attainment and maintenance of national ambient air quality standards in areas designated as non-attainment. The Amendments require that each state submit the SIP revisions to the U.S. Environmental Protecton Agency (EPA) by January 1, 1979. These proposed regulations should contain an oxidant plan submission for major urban areas to reflect the application of Reasonably Available Control Technology (RACT) to stationary sources for which the EPA has published guidelines. The Amendments also require that the states identify and analyze the air quality, health, welfare, economic, energy and social effects of the plan provisions.

Under the drection of Region IV, the EPA contracted with Booz, Allen & Hamilton Inc. (Booz, Allen) to assist the states of Alabama, Georgia, Kentucky, North Carolina, South Carolina and Tennessee in analyzing the economic, energy and social impacts of the SIP revisions proposed by these states. The assignment was initiated on September 28, 1978, and, as a first step, the proposed SIP revisions and the type of assistance desired by each state were reviewed.

After a review with each of the states and EPA Region IV representatives, a work scope was defined that would include in the study an analysis of the direct economic and energy impacts for those industrial segments most likely to have a significant impact at the statewide level. For the most part this included industrial categories that had more than a few facilities potentially affected. The next section discusses those specific industrial categories included in this work scope.

2.2 SUMMARY OF PROPOSED SIP REVISIONS IN NORTH CAROLINA AND THE STATE'S NEED FOR CONTRACTOR SUPPORT

North Carolina has recently revised its proposed regulations to reduce volatile organic compounds (VOC) emissions by implementing the Reasonably Available Control Technology (RACT) guidelines developed by the EPA for existing stationary sources. Its scope is limited to non-attainment areas for ozone in North Carolina. Currently only one area is designated as such--Mecklenburg County. The state is also studying implementation of motor vehicle inspection/maintenance programs in the non-attainment areas.

The state officials were interviewed to determine their need for support in analyzing the economic impact of the SIP revisions. The analysis of implementing the RACT guidelines for reducing VOC emissions was expressed as the fundamental concern. Specifically, the state needed assistance in the analysis of 2 of the 15 industrial categories for which the EPA has published RACT guidelines. These 2 RACT industrial categories are described in the next section. The other thirteen industrial categories (surface coating of coil, automobiles, large appliances, fabrics, cans metal furniture, and magnet wire insulation; miscellaneous refinery sources; bulk gasoline plants; service stations; use of cutback asphalt; solvent metal cleaning and storage of petroleum liquids in fixed roof tanks) were excluded from this study because none or a very limited number of sources were affected by the proposed regulation in those categories. Although the cost impact in those categories excluded might be significant for an individual firm studied, it is unlikely that the economic or energy impact of the macrolevel (countywide) would be significant.

2.3 SCOPE

The primary objective of this study is to determine the costs and impact of compliance with the proposed SIP revisions for six states in EPA Region IV. The study will emphasize the analysis of direct economic costs and benefits of the proposed SIP revisions. Secondary (employment and energy) impacts will also be addressed but are not the major study emphasis.

In the non-attainment area of ozone of North Carolina, the economic impact will be analyzed for the implementation of RACT guidelines to reduce VOC emissions from the following 2 industry categories:

- Surface coating of paper
- Bulk gasoline terminals

The major study guidelines in the determination of the economic impact of the RACT guidelines are discussed below.

- The emission limitations for each industrial category will be studied at the control level established by the RACT guidelines. These are presented in Exhibit 2-1, on the following page.

- All costs and emissions data were presented for 1977.

- Emissions sources included were existing stationary point sources in the applicable industrial categories with potential VOC emissions greater than 100 tons per year in Mecklenburg county, which is classified as nonattainment for ozone.

EXHIBIT 2-1
U.S. Environmental Protection Agency
LISTING OF EMISSION LIMITATIONS THAT REPRESENT THE PRESUMPTIVE NORM TO BE ACHIEVED THROUGH APPLICATION OF RACT FOR TWO INDUSTRY CATEGORIES

Category	RACT Guideline Emission Limitations[a] Surface Coating Categories Based on Low Organic Solvent Coatings (lbs. solvent per gallon of coating, minus water)
Surface Coating of Paper	2.9
Bulk Gasoline Terminals	Vapor control system may not allow mass emissions of VOC from control equipment to exceed 80 milligrams per liter (4.7 grains per gallon) of gasoline loaded.

a. Annotated description of RACT guidelines.

Source: Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, U.S. Environmental Protection Agency, EPA-90512-78-001, April 1978.

- The following volatile organic compounds were exempted:

  - Methane
  - Ethane
  - Trichlorotrifluorethane
  - 1,1,1 Trichloroethane (methyl chloroform).[1]

- The timing requirement for implementation of controls to meet RACT emission limitations was May 1, 1980 for cutback asphalt and May 1, 1982 for the other industry categories.

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[1] The exemption status of methyl chloroform under these guidelines may be subject to change.

2.4 APPROACH

This section describes the overall approach and methodology applied in this assignment. In general, the approach varied for each state and also for each industrial category studied. This section specifically describes the overall approach that was applied for the State of North Carolina. The methodology applied to determine the economic impact for each industrial category in the non-attainment areas of North Carolina is described in further detail in the first section of each chapter dealing with the specific industry category.

There are five parts to this section to describe the approach for determining estimates of:

- Industry statistics
- VOC emissions
- Process descriptions
- Cost of controlling VOC emissions
- Comparison of direct costs with selected direct economic indicators.

2.4.1. Industry Statistics

The assembly of economic and statistical data for each industrial category was an important element in establishing the data base that was used for projection and evaluation of the emissons impact. Some of the major variables for each industrial category were:

- Number of manufacturers
- Number of employees
- Value of shipments
- Number of units manufactured
- Capital expenditures
- Energy consumption
- Productivity indices

- Current economic (financial) status
- Industry concentration
- Business patterns (small vs. large; downstream integration)
- Age distribution of facilities
- Future trends and developments.

For the industrial categories studied, a more deliberate approach was applied to determine those facilities potentially affected.

- For the surface coating of paper category, the facilities potentially affected by the RACT guidelines were identified from both the state emission data and secondary data sources.
  - These two independently compiled lists were then correlated to identify the facilities potentially affected but not listed as VOC emitters in the state emission data. The North Carolina Department of Natural Resources and Community Development then verified those potentially affected facilities.
  - The Booz, Allen study team then performed telephone interviews with the facilities identified where there was doubt concerning inclusion.
- For bulk gasoline terminals the list of potentially affected facilities was compiled by the North Carolina Department of Natural Resources and Community Development.
- Industry category statistical data were compiled using secondary sources such as:
  - Department of Commerce
  - Census of Manufacturers
  - Trade associations
  - Bureau of Labor Statistics
  - National Technical Information Services.

- The industry statistical data were refined by two mechanisms:

  - Assessing the statistical data for reasonableness in comparison to the preliminary list of potentially affected facilities

  - Using industry and association interviews for completion and validation.

2.4.2 VOC Emissions

An approach that made maximum utilization of the existing state emission data was defined. State representatives were interviewed to determine the completeness and validity of emission data available for each RACT industrial category. It was determined that VOC emission data for all potentially affected industrial sources were not available. Therefore, emissions were determined by the Booz, Allen study team using different approaches depending upon the availability of data on emissions and characterisitcs of affected facilities.

- For bulk gasoline terminals, emissions were estimated by using facility characteristics data provided by the state and emission factors developed by U.S. EPA.

- For the surface coating of paper, emissions were obtained from the state emissions inventory as well as estimated by using data provided by the industry to Booz, Allen during telephone interviews (when not available in the emissions inventory).

2.4.3 Process Descriptions

For each of the industrial categories, the basic technology and emission date were reviewed and summarized concisely for subsequent evaluation of engineering alternatives. In this task, the RACT documents that had been prepared for each industrial category and other air pollution control engineering studies served as the basis for defining technological practice. Additional alternatives of control that met the requirements of the RACT guidelines were identified from literature search. The most likely control alternatives were assessed and evaluated by:

- Tehcnical staff at Booz, Allen
- Interviews with industry representatives
- Interviews with EPA representatives
- Interviews with equipment manufacturers.

2.4.4 Cost of Controlling VOC Emissions

The cost of control to meet the requirements of the RACT guidelines had been presented in the RACT documents, other technical EPA studies and trade journal technical documents and by industry representatives. The approach applied in developing capital and annualized cost estimates was to:

- Utilize available secondary source information as the primary data source
- Validate the control alternatives industry is likely to apply
- Calibrate these cost estimates provided in technical documents.

It was not within the purpose or the scope of this project to provide detailed engineering costs to estimate the cost of compliance.

Cost data presented within the body of the report were standardized in the following manner:

- All cost figures are presented for a base year, 1977.
- Capital cost figures represent installed equipment cost including:
  - Engineering
  - Design
  - Materials
  - Equipment
  - Construction.

  The capital cost estimates do not account for costs such as:
  - Clean-up of equipment
  - Lost sales during equipment downtime
  - Equipment start-up and testing
  - Initial provisions (spare parts).
- Capital related annual costs are estimated at 25 percent of the total capital cost per year (unless explicitly stated otherwise). The estimation procedure applied was built up from the following factors:

- Depreciation -- straight-line over a ten-year life

- Interest -- 10 percent

- Taxes and insurance -- 4 percent

- Maintenance -- 5 percent.

The capital-related annual costs do not account for investment costs in terms of return or investment parameters (i.e., the "opportunity cost" of money is not included).

. Annual operating costs of compliance with the RACT guidelines were estimated for each of the control alternatives studied. The annual operating costs included were:

- Direct labor
- Raw material costs (or savings)
- Energy
- Product recovery cost (or savings)
- Maintenance.

Other types of costs, not included in this analysis, involve compliance costs, such as:

- Demonstration of control equipment efficiency

- Supervisory or management time

- Cost of labor or downtime during installation and startup.

. The annualized cost is the total of direct operating costs (including product or raw material recovery) and the capital related annual costs.

2.4.5 Comparison of Direct Cost with Selected Direct Economic Indicators

In each of the industrial categories studied, after the costs (or savings) of compliance had been determined, these costs were compared with selected economic indicators. This comparison was performed to gain a perspective on the compliance costs rather than to estimate price changes or other secondary effects of the regulation. Presented below are typical comparisons of direct costs with indicators that are presented in this study.

- Annualized cost in relation to current price—To gain a perspective on the compliance cost in relation to current prices of the manufactured items at the potentially affected facilities, the annualized cost is presented in terms of a price increase assuming a direct pass-through of costs to the marketplace.

  - This analysis was based on the average cost change (including those facilities that may have little or no economic impact associated with meeting the proposed standards) divided by the average unit price of goods manufactured.

  - For this reason as well as many others (that might be addressed in a rigorous input-output study to estimate eventual price increase), this analysis should not be interpreted as forecast of price changes due to the proposed standards.

- Annualized costs as a percent of current value of shipment—The annualized costs applied are for all those facilities potentially affected divided by the estimated value of shipments for the statewide industrial category (i.e., including those facilities which currently may meet the proposed standard). This approach tends to understate the effect to those specific firms requiring additional expenditures to meet the proposed standard. Therefore, when available, the compliance cost is also presented as a percent of the value of shipments for only those firms not currently meeting the proposed regulation.

- Capital investment as a percent of current annual capital appropriations—Estimated statewide capital investment for the potentially affected facilities divided by the estimated capital appropriations for the industry affected as a whole in the state (including those facilities that may not require any capital investment to meet the proposed standard).

2.5 QUALITY OF ESTIMATES

The quality of the estimates that are presented in this report can be judged by evaluating the basis for estimates of the individual study components. In each of the chapters that deal with the development of estimated compliance cost, the sources of information are fully documented. In addition, the study team has categorically ranked the overall data quality of the major sources and, therefore, of the outcomes. These data quality estimates were ranked into three categories:

- High quality ("hard data")—study inputs with variation of not more than ± 25 percent
- Medium quality ("extrapolated data")—study inputs with variation of ± 25 to 75 percent
- Low quality ("rough data")—study inputs with variation of ± 50 to 150 percent.

Each of these data quality estimates is presented in the individual chapters. The overall quality ranking of the study inputs for each RACT industrial category was generally in the medium quality range.

2.6 DEFINITIONS OF TERMS

Listed below are definitions of terms that are used in the body of the report:

- Capture system--the equipment (including hoods, ducts, fans, etc.) used to contain, capture, or transport a pollutant to a control device.

- Coating applicator--an apparatus used to apply a surface coating.

- Coating line--one or more apparatuses or operations which include a coating applicator, flash-off area and oven, wherein a surface coating is applied, dried and/or cured.

- Control device--equipment (incinerator, adsorber or the like) used to destroy or remove air pollutant(s) prior to discharge to the ambient air.

- Continuous vapor control system--a vapor control system that treats vapors displaced from tanks during filling on a demand basis without intermediate accumulation.

- Direct cost pass-through--the relationship of the direct annualized compliance cost (increase or decrease) to meet the RACT limitations in terms of units produced (costs per unit value of manufactured goods.)

- Emission--the release or discharge, whether directly or indirectly, of any air pollutant into the ambient air from any source.

- Facility--any building, structure, installation, activity or combination thereof which contains a stationary source of air contaminants.

- Flashoff area--the space between the application area and the oven.

- Hydrocarbon--any organic compound of carbon and hydrogen only.

- Incinerator--a combustion apparatus designed for high temperature operation in which solid, semisolid, liquid or gaseous combustible wastes are ignited and burned efficiently and from which the solid and gaseous residues contain little or no combustible material.

- Intermittent vapor control system--a vapor control system that employs an intermediate vapor holder to accumulate vapors displaced from tanks during filling. The control device treats the accumulated vapors only during automatically controlled cycles.

- Loading rack--an aggregation or combination of gasoline loading equipment arranged so that all loading outlets in the combination can be connected to a tank truck or trailer parked in a specified loading space.

- Organic material--a chemical compound of carbon excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate.

- Oven--a chamber within which heat is used to bake, cure, polymerize and/or dry a surface coating.

- Prime coat--the first film of coating applied in a two-coat operation.

- Reasonably available control technology (RACT)--the lowest emission limit as defined by EPA that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories.

- Reid vapor pressure--the absolute vapor pressure of volatile crude oil and volatile nonviscous petroleum liquids, except liquified petroleum gases, as determined by American Society for Testing and Materials, Part 17, 1973, D-323-72 (Reapproved 1977).

- Shutdown--the cessation of operation of a facility or emission control equipment.

- Solvent--organic material which is liquid at standard conditions and which is used as a dissolver, viscosity reducer or cleaning agent.

- Standard conditions--a temperature of 20°C (68°F) and pressure of 760 millimeters of mercury (29.92 inches of mercury).

- Startup--the setting in operation of a source or emission control equipment.

- Stationary source--any article, machine, process equipment or other contrivance from which air pollutants emanate or are emitted, either directly or indirectly, from a fixed location.

- Topcoat--the final film of coating applied in a multiple coat operation.

- True vapor pressure--the equilibrium partial pressure exerted by a petroleum liquid as determined in accordance with methods described in American Petroleum Institute Bulletin 2517, "Evaporation Loss from Floating Roof Tanks," 1962.

- Equivalent barrel of oil--energy demand is converted into barrels of oil at the conversion rate of 6,000,000 BTU per barrel of oil.

- Vapor collection system--a vapor transport system which uses direct displacement by the liquid loaded to force vapors from the tank into a vapor control system.

- Vapor control system--a system that prevents release to the atmosphere of at least 90 percent by weight of organic compounds in the vapors displaced from a tank during the transfer of gasoline.

- Volatile organic compound (VOC)--any compound of carbon that has a vapor pressure greater than 0.1 millimeters of mercury at standard conditions excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate.

5.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING PAPER IN MECKLENBURG COUNTY

5.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR PLANTS SURFACE COATING PAPER IN MECKLENBURG COUNTY

This chapter presents a detailed analysis of the impact of implementing RACT for plants, located in Mecklenburg County in the State of North Carolina, which are engaged in the surface coating of paper. This is meant to include protective or decorative coatings put on paper, pressure-sensitive tapes regardless of substrate, related web coating processes on plastic film and decorative coatings on metal foil, but does not include conventional printing processes which apply inks.

This analysis includes those paper coaters in the non-attainment area with potential emissions greater than 100 tons per year.

The chapter is divided into five sections:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic impacts.

Each section presents detailed data and findings based on analyses of the RACT guidelines; previous studies of paper coating; interviews with paper coaters, coating equipment manufacturers and materials manufacturers; and a review of pertinent published literature.

5.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impacts

for plants engaged in the surface coating of paper. The quality of these estimates is discussed in the last part of this section.

5.1.1 Industry Statistics

Paper coating is practiced in a number of industries. Among products that are coated using organic solvents are: adhesive tapes; adhesive labels; decorated, coated and glazed paper; book covers; office copier paper; carbon paper; typewriter ribbons; photographic film; paper cartons; and paper drums. The firms coating paper are classified in a number of groupings in the U.S. Department of Commerce's Standard Industrial Classification system. The major coaters may be found in the following 16 SIC groups:

SIC	Description
2611	Pulp mills
2621	Paper mills, except building paper mills
2631	Paperboard mills
2641	Paper coating and glazing
2643	Bags, except textile bags
2645	Diecut paper and paperboard and cardboard
2649	Paper converting, n.e.c.
2651	Folding paperboard boxes
3291	Abrasive products
3292	Asbestos products
3293	Gaskets, packing and sealing devices
3497	Metal foil and leaf
3679	Electronic components, n.e.c.
3842	Orthopedic, prosthetic and surgical appliances and supplies
3861	Photographic equipment and supplies
3955	Carbon paper and inked ribbons

This list does not include plants listed in the SIC category 2700 (Printing, Publishing and Allied Industries), where paper coating other than printing may also be a part of the overall processing of the printed product.

Statistics concerning these industries were obtained from a number of sources. All data where possible were converted to the base year 1977 for the state, using scaling factors developed from U.S. Department of Commerce data as presented in County Business Patterns. The primary sources of economic data were the 1972 Census of Manufactures and 1976 Annual Survey of Manufactures.

The list of firms in Mecklenburg County likely to be affected by the proposed regulations was compiled by Booz, Allen using the 1976-77 Directory of North Carolina Manufacturing Firms and was crosschecked with the list compiled by the North Carolina Department of Natural Resources and Community Development (DNRCD) and the Mecklenburg County Department of Environmental Health. The state and county officials conducted telephone interviews with the identified firms to resolve any conflict between the two lists. Based on the above information, three firms were identified as paper coaters in the county, two of which had potential VOC emissions greater than 100 tons per year.

Employment data for these firms were obtained by Booz, Allen through telephone interviews with the company representives.

5.1.2 VOC Emissions

Source emissions data for the three paper coaters in Mecklenburg County were obtained from the state and county officials.

5.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions from sources included in the paper coating category are described in Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II (EPA-450/2-77-008). The feasibility of applying the various control methods to paper coating discussed in this document was reviewed with coating firms, coating suppliers, coating equipment manufacturers and industry associations. These methods include both coating reformulation and the use of control devices, such as incinerators and carbon adsorbers.

Because of the wide variety of coating processes and coating materials in use, most methods of control will find some applicability. The situations where emissions are likely to be controlled by reformulation and by control devices were estimated based on a review of the literature and on information obtained from an interview with several of the North Carolina coaters.

5.1.4 Cost of Control and Estimated Reduction of VOC Emissions

The overall costs of control of VOC emissions in accord with the proposed regulations were determined from:

- Generalized cost formulas based on estimated emissions and judgment as to the type of control to be used
- A development of capital, operating and energy requirements for the facilities that will be affected, based on the generalized cost correlations
- Aggregation of the findings for each plant affected.

The generalized cost correlations used are to be found in:

- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume I (EPA-450/2-76-028)
- Air Pollution Control Engineering and Cost Study of General Surface Coating Industry, Second Interim Report, Springborn Laboratories

Additional cost data were supplied by equipment and material suppliers and published literature sources. Major coaters in other states have been consulted to determine industry views on acceptable control methods and, in some cases, to confirm the cost estimating formula.

5.1.5 Economic Impacts

The projected effect of RACT implementation on price is based on an indicator which is the incremental cost related to the total sales or cost of the product within the state. The procedure is described below:

- Relate incremental costs to total statewide figures.
- Also relate incremental costs to the part of the statewide production that is affected by the regulation (firms not now meeting RACT).
- Where data are available, show the range of ratios for individual locations.
- Where the industry has been segmented, show the range of cost ratios for applicable industry segments.

The cost per unit of production is an indicator of potential price effect rather than a prediction of the price effect to be expected.

The economic impacts were determined by analyzing the lead time requirements to implement RACT, assessing the feasibility of instituting RACT controls in terms of capital and equipment availability, comparing the direct costs of RACT control to various state economic indicators and assessing the secondary effects on market structure, employment and productivity as a result of implementing RACT controls in the county.

5.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls on the surface coating of paper in Mecklenburg County. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (data that are published for the base year), "B" indicates data that were extrapolated from hard data and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analysis of previous studies and best engineering judgment. Exhibit 5-1, on the following page, rates each study output listed and the overall quality of the data.

EXHIBIT 5-1
U.S. Environmental Protection Agency
DATA QUALITY--SURFACE COATING OF PAPER

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics		X	
Emissions	X		
Cost of emissions control			X
Economic impact			X
Overall quality of data			X

Source: Booz, Allen & Hamilton Inc.

5.2 INDUSTRY STATISTICS

Industry characteristics, statistics and trends for paper coating in Mecklenburg county are presented in this section. This information forms the basis for assessing the total impact of implementing RACT for control of VOC emissions in the county and for the effect upon individual firms.

5.2.1 Size of the Industry

The 1976-77 Directory of North Carolina Manufacturing Firms reports a total of 123 firms in 16 SIC categories in North Carolina where paper coating, as defined in proposed RACT guidelines, is the main business of the firm or may be a part of its manufacturing activity. The number of firms and other relevant statistics in each SIC grouping are summarized in Exhibit 5-2, on the following page.

Total value of shipments for these firms is estimated to be about $2.31 billion, with a total of about 26,100 employees. New capital expenditures are estimated to be about $338 million annually, based on the most recent (1976) Annual Survey of Manufactures.

In Mecklenburg County, only three firms have been identified as paper coaters, as defined in the proposed regulation. The three firms are listed in Exhibit 5-3, following Exhibit 5-2. They employ 1,105 employees and have an estimated annual value of shipment of $70,000 per employee, which is characteristic of the firms in SIC 2641 paper coating.

Two of the three firms (Rexham Corp., Pinesville, and Rexham Corp., Matthews) have potential emissions sufficiently high to be affected by the proposed regulations. These two firms employ a total of 505 employees and have an estimated annual value of shipments of $35.3 million.

5.2.2. Comparison of the Industry to the State Economy

A comparison of the value of shipments of the 123 plants in the 16 SIC categories listed in Section 5.1.1 with the total state manufacturing economy ($31.4 billion) indicates that these plants represent about 7.4 percent of the total value of manufacturing shipments in North Carolina. These 123 firms employ about 3.7 percent of

EXHIBIT 5-2
U.S. Environmental Protection Agency
1976 INDUSTRY STATISTICS--SURFACE
COATING OF PAPER SIC GROUPS IN NORTH CAROLINA

SIC Code	Description	Number of Plants	Total Number of Employees	Total Payroll ($1,000,000)	Estimated Value of Shipments[a] ($1,000,000)	Estimated New Expenditures[a] ($1,000,000)
2611	Pulp mills	5	6,925	123	941	178
2621	Paper mills, except building paper mills	6	6,060	100	581	53.6
2631	Paperboard mills	6	5,395	90.8	315	75.7
2641	Paper coating and glazing	7	629	6.21	51.1	1.59
2643	Bags, except textile bags	9	673	8.15	46.7	1.35
2645	Diecut paper and paperboard and cardboard	9	768	9.10	53.5	1.56
2649	Paper converting, n.e.c.	12	590	5.35	33.6	.707
2651	Folding paperboard boxes	17	1,053	13.3	60.2	1.84
3291	Abrasive products	6	175	2.36	10.6	.342
3292	Asbestos products	7	719	7.81	44.5	.939
3293	Gaskets, packing and sealing devices	3	375	4.38	14.3	.527
3497	Metal foil and leaf[b]	2	60	.809	4.97	.121
3679	Electronic components, n.e.c.	10	956	8.54	41.7	17.7
3842	Orthopedic, prosthetic and surgical appliances and supplies	17	743	5.48	32.7	1.16
3861	Photographic equipment and supplies	6	768	13.3	65.8	2.68
3955	Carbon paper and inked ribbons[b]	1	175	2.19	13.7	.257
Total		123	26,064	401	2,310	338

a. Estimated by using ratios of (value of shipment/total employment) and (capital expenditures/total employment) for each SIC group as published in 1976 Annual Survey of Manufactures where value of shipments or expenditures are not tabulated for the state.

b. None listed.

Source: Booz, Allen & Hamilton Inc.: 1976 County Business Patterns, and 1976 Annual Survey of Manufactures, U.S. Department of Commerce and the 1976-77 Directory of North Carolina Manufacutring Firms.

EXHIBIT 5-3
U.S. Environmental Protection Agency
COMPANIES COATING PAPER IN MECKLENBURG COUNTY

Company Name Town (County)	SIC	Employees
Package Products Co. (3 plants) Charlotte (Mecklenburg)	2621 2643	600
Rexham Corp. Matthews (Mecklenburg)	3079 2621	266
Rexham Corp. Pinesville (Mecklenburg)	2651	239
Total		1,105

Source: Booz, Allen & Hamiltion, North Carolina Department of Natural Resources and Community Development, and the Mecklenburg County Department of Environmental Health.

the 711,000 manufacturing employees in the state. The three firms having paper coating operations represent 0.25 percent of the total value of manufacturing shipments in North Carolina and employ about 0.15 percent of all manufacturing employees in the state.

The two directly affected firms represent 0.11 percent of the total value of manufacturing shipments in North Carolina and employ about 0.07 percent of all manufacturing employees in the state.

5.2.3 Historical and Future Patterns of the Industry

The nationwide value of shipments in the industries expected to be affected by the proposed paper coating regulations, in general, exceed the growth rate of the economy. As summarized in Exhibit 5-4, on the following page, the value of shipments increased in every category between 1972 and 1976, with an average annual growth rate of about 12.1 percent over the period. Compared to an average inflationary rate of 6 to 8 percent, this is equivalent to a real growth rate of 4 to 6 percent. In some individual categories, growth rates were even greater. Paper production increased by an uncorrected average annual growth rate of 16.5 percent; metal and foil by 16 percent; paper coating and glazing by about 12 percent, only slightly less than the average. It is expected that the growth rate will continue at these rates for the near future.

EXHIBIT 5-4
U.S. Environmental Protection Agency
HISTORICAL TRENDS IN VALUE OF SHIPMENTS OF
U.S. PLANTS ENGAGED IN PAPER COATING ($ millions)

SIC Code	1972	1973	1974	1975	1976
2611	710	849	1,525	1,630	2,055
2621	6,385	7,514	9,942	9,650	11,768
2631	4,153	4,862	6,516	6,055	6,724
2641	1,954	2,284	2,645	2,626	3,074
2643	1,886	2,183	2,867	2,980	3,379
2645	676	747	923	943	1,027
2649	631	833	1,079	1,090	1,288
2651	1,487	1,644	1,890	1,952	2,223
3291	888	1,067	1,235	1,222	1,433
3292	763	823	963	900	988
3293	665	723	835	843	1,020
3499	702	753	973	1,065	1,267
3679	3,060	3,430	3,210	3,450	4,120
3842	1,450	1,620	1,800	2,090	2,240
3861	5,624	6,435	7,490	7,627	8,844
3955	237	268	309	285	294
Total	31,271	36,035	42,400	44,408	51,744

Source: 1976 Annual Survey of Manufactures, U.S. Department of Commerce.

5.3 TECHNICAL SITUATION IN THE INDUSTRY

This section briefly describes the general process and materials used in the surface coating of paper and similar products proposed to be included under the RACT Surface Coating of Paper regulations. The technology is fully described in the RACT documents.[1] The products include a myriad of consumer and industry oriented items, such as pressure-sensitive tapes, adhesive labels, book covers, milk cartons, flexible packaging materials and photographic film. Although many of these products are also printed in one manner or another, the emissions from printing inks are not included in the RACT regulations pertaining to paper coating; only the emissions specifically issuing from the coating operation are included. An estimate of these emissions for the state is also presented in this section.

5.3.1 General Coating Process Description

In organic solvent paper coating, resins are dissolved in an organic solvent mixture and this solution is applied to a web (continuous roll) of paper. As the coated web is dried, the solvent evaporates and the coating cures.

Most organic solventborne coating is done by paper converting companies that buy paper from the mills and apply coatings to produce a final product. The paper mills themselves sometimes apply coatings, but these are usually waterborne coatings consisting of a pigment (such as clay) and a binder (such as starch or casein). However, much additional coating is done by firms only as part of the manufacturing process.

Solvent emissions from an individual coating facility will vary with the size and number of coating lines. A plant may have one or as many as 20 coating lines. Uncontrolled emissions from a single line may vary from 50 pounds per hour to 1,000 pounds per hour, depending on the line size. The amount of solvent emitted also depends on the number of hours the line operates each day.

Exhibit 5-5, on the following page, gives typical data from various paper coating applications.

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[1] Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II, EPA-450/2-77-008

EXHIBIT 5-5
U.S. Environmental Protection Agency
EMISSION DATA FROM TYPICAL PAPER COATING PLANTS

Number of coating lines	Solvent Usage (lb./day)	Solvent Emissions (lb./day)	Control Efficiency (%)[a]	Control Device
2	10,000	10,000	-	None
5	15,000	15,000	-	None
8	9,000	9,000	-	None
2	1,200	1,200	-	None
10	24,000	950	96	Carbon adsorption
20	55,000	41,000	90	Carbon adsorption (not all lines controlled)
3	5,000	1,500	90	Carbon adsorption
3	21,000	840	96	Carbon adsorption
1	10,500	500	96	Afterburner

a. Neglecting emissions that are not captured in the hooding system.

Source: Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/2-77-008.

5.3.2 Nature of Coating Materials Used

The formulations usually used in organic solventborne paper coatings may be divided into the following classes: film-forming materials, plasticizers, pigments and solvents. Dozens of organic solvents are used. The major ones are: toluene, xylene, methyl ethyl ketone, isopropyl alcohol, methanol, acetone and ethanol.

Although a single solvent is frequently used, often a solvent mixture is necessary to obtain the optimum drying rate. Too rapid drying results in bubbles and an "orange peel" effect in the coating; whereas, slow drying coatings require more time in the ovens or slower production rates. Variations in the solvent mixture also affect the solvent qualities of the mix.

The main classes of film formers used in conventional paper coating are cellulose derivatives and vinyl resins. The most commonly used cellulose derivative, nitrocellulose has been used for paper coating decorative paper, book covers and similar items since the 1920s. It is relatively easy to formulate and handle, and it dries quickly, allowing lower oven temperatures than vinyl coatings. The most common vinyl resin is the copolymer of vinyl chloride and vinyl acetate. These vinyl copolymers are superior to nitrocellulose in toughness, flexibility and abrasion resistance. They also show good resistance to acids, alkalies, alcohols and greases. Vinyl coatings tend to retain solvent, however, so that comparatively high temperatures are needed. In general, nitrocellulose is most applicable to the decorative paper field, whereas vinyl copolymers are used for functional papers, such as some packaging materials.

In the production of pressure-sensitive tapes and labels, adhesives and silicone release agents are applied using an organic solvent carrier. The adhesive layer is usually natural or synthetic rubber, acrylic or silicone. Because of their low cost, natural and synthetic rubber compounds are the main film formers used for adhesives in pressure-sensitive tapes and labels, although acrylic and silicone adhesives offer performance advantages for certain applications. In most cases, tapes and labels also involve the use of release agents applied to a label carrier or the backside of tape to allow release. The agents are usually silicone compounds applied in a dilute solvent solution.

5.3.3 VOC Emissions and Current Controls

Current VOC emissions from the three paper coating firms are 891 tons per year, as shown in Exhibit 5-6, on the following page. The two affected firms emit 881 tons per year of VOC.

VOC emissions controls are employed only at the Matthews plant of Rexham Corp. Of a total of eight coating lines in this plant, two lines are equipped with carbon adsorption units with a 95 percent VOC removal efficiency and two more are equipped with incinerators, also with a 95 percent removal efficiency. One of the incinerators, however, is used only when coating specific products, resulting in an annual use of only 25 percent of plant operating time.

5.3.4 RACT Guidelines

The RACT guidelines for control of VOC emissions from the surface coating of paper require that emission discharges of VOCs be limited to 2.9 pounds per gallon of coating material delivered to the coating applicator.

The recommended methods of achieving this requirement are:

- The application of low solvent content coatings; or
- Incineration, provided that 90 percent of the nonmethane VOCs (measured as combustible carbon) which enter the incinerator are oxidized to carbon dioxide and water; or
- A system demonstrated to have control efficiency equivalent to or greater than that provided by either of the above methods.

In the following section are discussed several methods of low solvent and solventless systems which have been demonstrated to be applicable to some paper coating products, and the two principal add-on systems, incineration and carbon adsorption, generally used for emission control. This information has been extracted principally from the previously cited EPA report, Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II (EPA-450/2-77-008), which should be

EXHIBIT 5-6
U.S. Environmental Protection Agency
VOC EMISSIONS FROM PAPER COATING FACILITIES
IN MECKLENBURG COUNTY IN 1977

Firm	Location	VOC Emissions Actual[a] (tons /yr)	VOC Emissions Potential[b] (tons /yr)
Rexham Corp.	Matthews	850	1193
Rexham Corp.	Pinesville	31	136
Package Products, Co.	Charlotte	10	44

a. Data provided by North Carolina Department of Natural Resources and Community Development and Mecklenburg County, Department of Environmental Health.

b. Booz, Allen estimate based on the operating hours data provided by state and county officials except for Package Products, Co. which was assumed to operate 2,000 hours per year.

Source: Booz, Allen & Hamilton Inc.

consulted for a more thorough discussion. In some instances, additional information was obtained from coaters, coating material suppliers and control equipment manufacturers.

5.3.5 Low Solvent and Solventless Coatings

In Exhibit 5-7, on the following page, are listed several types of coating materials which have found utility in paper coating, and an estimate of expected solvent reduction.

5.3.5.1 Waterborne Coatings

Waterborne coatings have long been used in coating paper to improve printability and gloss. However, newer coatings have been developed in which a synthetic insoluble polymer is carried in water as a colloidal dispersion or an emulsion. This is a two-phase system in which water is the continuous phase and the polymer resin is the dispersed phase. When the water is evaporated and the coating cured, the polymer forms a film that has properties similar to those obtained from organic-solvent-based coatings.

5.3.5.2 Plastisols and Organisols

Plastisols are a colloidal dispersion of synthetic resin in a plasticizer. When the plasticizer is heated, the resin particles are solvated by the plasticizer so that they fuse together to form a continuous film. Plastisols usually contain little or no solvent, but sometimes the addition of a filler or pigment will change the viscosity so that organic solvents must be added to obtain desirable flow characteristics. When the volatile content of a plastisol exceeds 5 percent of the total weight, it is referred to as an organisol.

Although organic solvents are not evaporated from plastisols, some of the plasticizer may volatilize in the oven. This plasticizer will condense when emitted from the exhaust stack to form a visible emission.

5.3.5.3 Hot Melt Coatings

Hot melt coatings contain no solvent; the polymer resins are applied in a molten state to the paper surfaces.

EXHIBIT 5-7
U.S. Environmental Protection Agency
ACHIEVABLE SOLVENT REDUCTIONS USING LOW SOLVENT COATINGS IN PAPER COATING INDUSTRY

Type of Low Solvent-Coating	Reduction Achievable (%)*
Waterborne coatings	80-99
Plastisols	95-99
Hot melts	99+
Extrusion coatings	99+
Pressure-sensitive adhesives	
Waterborne	80-99
Hot melts	99
Prepolymer	99
Silicone release agents	
100 percent nonvolatile coatings	99+
Waterborne emulsions	80-99

* Based on comparison with a conventional coating containing 35 percent solids by volume and 65 percent organic solvent by volume.

Source: Control of Volatile Organic Emissions From Existing Stationary Sources, Volume II, EPA-450/2-77-008.

All the materials deposited on the paper remain as part of the coating. Because the hot melt cools to a solid coating soon after it is applied, a drying oven is not needed to evaporate solvent or to cure the coating. Energy that would have been used to heat an oven and to heat makeup air to replace oven exhaust is therefore saved.

One disadvantage with hot melt coatings is that materials that char or burn when heated cannot be applied by hot melt. Other materials will slowly degrade when they are held at the necessary elevated temperatures.

5.3.5.4 Extrusion Coatings

A type of hot melt coating, plastic extrusion coating is a solventless system in which a molten thermoplastic sheet is discharged from a slotted dye onto a substrate of paper, paperboard or synthetic material. The moving substrate and molten plastic are combined in a nip between a rubber roll and a chill roll. A screw-type extruder extrudes the coating at a temperature sometimes as high as 600°F. Low and medium density polyethylene are used for extrusion coating more than any other types of resins.

5.3.5.5 Pressure-Sensitive Adhesive Coatings

Waterborne adhesives have the advantage that they can be applied with conventional coating equipment. Waterborne emulsions, which can be applied less expensively than can solventborne rubber-based adhesives, are already in use for pressure-sensitive labels. A problem with waterborne adhesives is that they tend to cause the paper substrate to curl and wrinkle.

Prepolymer adhesive coatings are applied as a liquid composed of monomers containing no solvent. The monomers are polymerized by either heat or radiation. These prepolymer systems show promise, but they are presently in a developmental stage only.

5.3.5.6 Silicone Release Coatings

Silicone release coatings, usually solventborne, are sometimes used for pressure-sensitive, adhesive-coated products. Two low-solvent alternatives are currently on

the market. The first is a 100 percent nonvolatile coating which is usually heat cured, but may be radiation cured. The second system is a water emulsion coating which is lower in cost than the prepolymer coating. However, because of wrinkling and other application problems the waterborne coating may be of limited value.

Some silicone coating materials which are under development use single solvent systems that can be readily recovered by carbon adsorption. Current coatings are troublesome since some silicone is carried into the adsorber where it clogs the carbon pores to reduce adsorption efficiency.

5.3.6 Incineration

Catalytic and direct thermal incineration processes convert hydrocarbons to carbon dioxide and water at high temperatures. Incineration is widely accepted as a reliable means of reducing hydrocarbon emissions by 90 percent or more.

Generally, the major disadvantage of this approach is the increased energy required to raise the exhaust gas temperatures above 1,200°F for direct incineration and 700°F for catalytic incineration. Another problem is the generation of nitrogen oxides in direct fired incinerators because of the exposure of air to high-temperature flames.

The increased energy consumption can, in some cases, be reduced or eliminated by heat exchange of the exhaust gases with fresh emissions (primary heat recovery) or by use of the hot incinerator exhaust gases in process applications (secondary heat recovery). Typical use of secondary heat recovery is for oven heat in drying or baking ovens. In fact, with efficient primary exchange and secondary heat recovery, total fuel consumption of an incinerator-oven system can be less than that for the oven before the incinerator is added. The heat required to sustain the system comes from the combustion of the volatile organic compounds in the exhausts.

Paper coaters who use coating machinery for a multiplicity of processes have commented that catalytic incineration would probably not be used because of the possibility of catalyst poisoning. Direct incineration would be used.

5.3.7 Carbon Adsorption

Carbon adsorption has been used since the 1930s for collecting solvents emitted from paper coating operations. Most operational systems on paper coating lines were installed because they were profitable. Pollution control has usually been a minor concern.

Carbon adsorption is most adaptable to single solvent processes. Many coaters using carbon adsorption have reformulated their coatings so that only one solvent is required. Toluene, a widely used solvent for paper coating, is readily captured in carbon adsorption systems.

The greatest obstacle to the economical use of carbon adsorption is that, in some cases, reusing recovered solvents may be difficult. In many coating formulations, a mixture of several solvents is needed to attain the desired solvency and evaporation rates. Also if different coating lines within the plant use different solvents and are all ducted to one carbon adsorption system, then there may be difficulty reusing the collected solvent mixture. In some cases, such as in the preparation of photographic films or thermographic recording paper, extremely high purity solvents are necessary to maintain product performance and even distillation may be insufficient to produce the quality of recovered solvent needed. For most other coating formulations, distillation is adequate.

Another problem with carbon adsorption is the potential of generating explosive conditions in the adsorber because of the localized increases in combustible organic material concentrations. Ignition apparently can be caused by static electricity in systems where dry air at high flow rates is treated. Several explosions of adsorbers have been reported in paper coating and other plants.

Also, adsorption of solvents containing water soluble compounds (such as alcohols, ketones or esters) can present a secondary pollution problem in the water effluent, where steam is used for regeneration. Additional treatment of the condensed steam with its content of dissolved organics would be required, increasing the complexity of the solvent recovery system and its cost.

5.4 COST AND VOC REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

This section discusses the projected costs of control for paper coating in the state based on the emissions as discussed in Section 5.3.3 of this report. Where possible, the validity of the costs were confirmed with coating firms and equipment manufacturers.

It is projected that the two affected firms in Mecklenburg County will use incineration or carbon adsorption to comply with the proposed regulations.

5.4.1 Costs of Alternative Control Systems

Carbon adsorption and incineration system costs were derived from estimates given in EPA-450/2-76-028. The cost estimates for both systems are based on the assumption that exhaust air flow rates can be reduced sufficiently to attain low explosion limit (LEL) levels of 25 percent. This is possible with well-designed ovens where excess air can be reduced or where product characteristics allow. Lower LEL levels require higher air flow and thus result in higher control costs.

Several paper coaters indicate that achieving 25 percent of LEL may not be possible with some coating lines, particularly older ones, or with certain types of coatings. Coating drying rate is a function of air flow rate, temperature and vapor concentration in the air. If air flow rates are to be reduced, drying temperatures or drying times must be increased. Because of the heat sensitivity of some coatings, temperature increases may not be possible. Increase in drying time will necessitate either longer ovens or reduced production rates. Several coaters of heat sensitive products indicated that, to achieve special characteristics, they could not increase emission concentrations above 5 to 6 percent of LEL and could not use oven temperatures above 140°F. Plants manufacturing conventional coated products, however, can decrease air flow rates sufficiently to increase VOC concentrations in the exhausts to 40-50 percent of LEL with only moderate increases in temperatures or changes in production rates. It has been assumed, for cost estimation purposes, that a 25 percent LEL can be attained on the average.

Incinerator costs are a function of equipment size, which varies generally with air flow rate. In most plants, it is impractical to manifold exhausts so that all exhausts could be treated in one add-on emission control system.

The major problem in estimating total installed costs of control systems is the cost of installation. The Booz Allen estimates were made on the assumption of a moderately difficult retrofitted system. In specific situations, some coaters have found actual installed costs to be three to five times those presented in the EPA document referred to earlier.

5.4.2 Estimated Countywide Costs

The total emissions considered to be applicable under RACT, as discussed in Section 5.3.4 of this report, are 881 tons per year for the two directly affected firms.

The air flow rates for these firms were determined on the assumption of a 25 percent approach to LEL, other assumptions summarized in Exhibit 5-8, on the following page, and each firm's current estimated emissions. These air flow rates were then used to estimate costs from EPA-450/2-76-028.

By applying these cost estimating procedures, the capital costs for add-on groups were estimated to be $0.5 million, with annualized costs of $45,000. Both are adjusted for inflationary increases from mid-1975 (base period for EPA-450/2-76-028 data) to mid-1977.

However, discussions with equipment manufacturers and coaters and review of published information indicated that these capital costs are probably three to four times lower than those experienced in recent retrofit situations. This issue is also addressed in EPA-450/2-76-028 which indicated that baseline capital costs could be 1.5 to 3 times higher because of various retrofit difficulties.

Therefore, assuming a 3 to 4 multiplier for capital costs which includes an adjustment for inflationary increases from mid-1975 to mid-1977, it is estimated that actual capital costs for the county are more likely to range from $1.5 million to $1.9 million, with corresponding annualized costs of $0.35 million to $0.5 million.

EXHIBIT 5-8
U.S Environmental Protection Agency
SUMMARY OF ASSUMPTIONS USED IN COST ESTIMATE

Assumptions

40 percent of emissions are controlled by incineration with primary heat recovery; 35 percent by carbon adsorption with recovered solvent credited at fuel prices.

25 percent LEL is equal to 3,000 ppm of MEK by volume.

Air flow can be reduced to reach 25 percent LEL

No costs are added for distillation or additional waste disposal.

Other assumptions regarding incinerator and adsorber prices, as estimated in Control of Volatile Organic Emissions from Existing Stationary Sources, Vol. I: Control Methods for Surface-Coating Operations, EPA-450/2-76-028, are valid.

Source: Booz, Allen & Hamilton Inc.

5.4.3 Estimated Emission Reduction

Assuming that 90 percent of all solvents used in coating operations can be collected by properly designed hoods and ovens, emissions could be reduced by 714 tons per year. This is based on a 90 percent capture and 90 percent destruction of emissions in an incinerator or 90 percent recovery in a carbon adsorption system (an overall reduction in emissions of 81 percent).

5.5 DIRECT ECONOMIC IMPACTS

This section presents the direct economic implications of the RACT guidelines for surface coating of paper on a statewide basis. The analysis includes the availability of equipment and capital; feasibility of the control technology; and impact on economic indicators, such as value of shipments, unit price (assuming full cost pass-through), state economic variables and capital investment.

5.5.1 RACT Timing

Current proposed guidelines for paper coating suggest several compliance deadlines for alternative methods of compliance.[1] Generally, for add-on systems, they call for installation of equipment and demonstration by mid-1980 or late 1980; for low solvent systems, by late 1980 or mid-1981, depending upon the degree of research and development needed. Major coaters, material suppliers and equipment manufacturers believe these deadlines to be unattainable.

- Normally, large incinerator and carbon adsorption systems will require about a year or more from receipt of purchase order to install and start up the system. Engineering may require three months or more, fabrication three to six months and installation and startup as long as three months.

- Only a few companies manufacture incineration systems with proven high heat recovery. The cumulative effect of equipment requirements by all firms in the U.S. needing control devices could severely impede the ability of these firms to supply equipment. In some cases, the most efficient devices are only now undergoing initial trials, and no production capacity has been developed.

In general, it appears that if add-on control systems are used, deadlines may have to be extended based on national demand.

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[1] Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, EPA-305/2-78-001, April 1978.

5.5.2 Technical Feasibility Issues

Though low solvent or solventless materials are used in many paper coating operations at present, many types of solvent-based systems currently have no satisfactory replacement. In many cases, the alternative materials do not meet the product quality standards demanded by the coaters and their customers. Additional development is needed and will require the combined efforts of both the coaters (who must maintain finished product quality) and the coating material suppliers. While the time required to develop the low solvent materials is difficult to estimate, it is unlikely that new coatings can be commercialized by 1981. Ideally, the new coating materials should be adaptable to existing coating equipment to minimize additional capital investment.

As discussed above, both incineration and carbon adsorption are not completely satisfactory add-on control systems. Incineration requires large volumes of additional fuel if good heat recovery is not accomplished; carbon adsorption is not usable on many coating systems because of the multiplicity of compounds used in solvent mixtures.

5.5.3 Comparison of Direct Cost with Selected Direct Economic Indicators

The net increase in annualized costs to coaters was estimated at $0.35 million to $0.5 million. These additional costs are projected to represent 0.45 to 0.65 percent of the total annual value of shipments of the three firms coating paper in Mecklenburg County and 1.06 to 1.5 percent of the shipments of the two firms directly impacted by the proposed regulations. Assuming a "direct passthrough" of these costs, prices at the two firms can be expected to increase by 1.06 to 1.5 percent.

The above estimates of price increase are based on a comparison of the cost of control with the total value of shipments by the affected firms. Since only a part of some of these firms' business represents paper coating operations affected by the regulations, the price increase for the affected products would be higher. Such price increases might make these firms less competitive with firms not affected by similar regulations elsewhere.

Another major economic impact in terms of cost to most individual companies will be the large capital expenditures required for add-on devices. For most companies, these costs would exceed their current level of capital expenditures for plant improvement and expansion. A large pressure-sensitive paper coater in another state, for instance, has estimated that a capital investment of about $2 million would be needed to meet proposed guidelines. His current annual capital expenditure program is normally in the range of $1.5 million.

5.5.4 Selected Secondary Economic Impacts

Implementing RACT in Mecklenburg County is not expected to have a significant impact on employment, market structure and productivity.

5.5.5 Impact of Compliance upon Energy Consumption

Based on the projection that 40 percent of affected emissions would be controlled by installation of direct flame incinerators with primary heat recovery (at 35 percent effeciency) and 60 percent by carbon adsorption, energy consumption is expected to increase by an amount equal to approximately 1,300 barrels of oil annually.[1] This is equivalent to approximately 12 million cubic feet of natural gas annually. This increased requirement is considered to be negligible compared to current county consumption.

* * * *

Exhibit 5-9, on the following page, summarizes the conclusions reached in this study and the implications of the estimated costs of compliance for paper coaters.

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1 The estimate is based further on the assumption that oven exhausts are about 300°F, that about 8 pounds of steam are used per pound of solvent recovered and that a barrel of oil is equivalent to 6.0×10^6 BTUs.

EXHIBIT 5-9
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF
IMPLEMENTING RACT FOR PAPER COATERS
IN MECKLENBURG COUNTY
IN THE STATE OF NORTH CAROLINA

Current Situation	Discussion
Number of potentially affected facilities	Two plants are expected to be affected by these regulations. However, if this category were to be interpreted to include all types of paper coating, including publishing, far more firms would be affected.
Indication of relative importance of the industrial sector to the state economy	The 1977 value of shipments of these two plants is estimated to be about $33 million. They are estimated to employ 505 people.
Current industry technology trends	Gravure coating replacing older systems.
1977 VOC emissions (actual)	Approximately 881 tons per year from two plants affected by RACT.
Industry preferred method of VOC control to meet RACT guidelines	Though low solvent use is increasing, progress is slow. Add-on control systems will probably be used.
Assumed method of control to meet RACT guidelines	Thermal incineration with primary heat recovery and carbon adsorption.
Affected Areas in Meeting RACT	**Discussion**
Capital investment (countywide)	Estimated to be $1.5 million to $1.9 million depending on retrofit situations. This is likely to be more than 100 percent of normal expenditures for the affected paper coaters.
Annualized cost (countywide)	$0.35 million to $0.5 million annually. This represents 1.1 to 1.5 percent of the value of shipments for the two firms directly affected.
Price	Assuming a "direct cost pass-through"-- 1.1 to 1.5 percent at the two affected firms.

EXHIBIT 5-9(2)
U.S. Environmental Protection Agency

Affected Areas in Meeting RACT	Discussion
Energy	Assuming 35 percent heat recovery from the incineration system, annual energy requirements are expected to increase by approximately 1,200 equivalent barrels of oil.
Productivity	No major impact.
Employment	Marginal impact possible.
Market structure	Marginal impact possible.
RACT timing requirements (1982)	Equipment deliverables and installation of incineration systems prior to 1982 are expected to present problems. Development of low solvent systems is likely to extend beyond 1982.
Problem areas	RACT guideline needs clear definition for enforcement. Retrofit situations and installation costs are highly variable. Type and cost of control depend on particular solvent systems used and reduction in air flow.
VOC emissions after control	Approximately 167 tons/year (19 percent of 1977 VOC emission level from two affected plants).
Cost effectiveness of control	$490 - $700 annualized cost/annual ton of VOC reduction.

Source: Booz, Allen & Hamilton Inc.

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13.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY

13.0 THE ECONOMIC IMPACT OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY

This chapter presents a detailed analysis of the impact of implementing RACT controls for tank truck gasoline loading terminals in Mecklenburg County. The chapter is divided into six sections including:

- Specific methodology and quality of estimates
- Industry statistics
- The technical situation in the industry
- Cost and VOC reduction benefit evaluations for the most likely RACT alternatives
- Direct economic implications
- Selected secondary economic impacts.

Each section presents detailed data and findings based on the RACT guidelines, previous studies of tank truck gasoline loading terminals, interviews and analysis.

13.1 SPECIFIC METHODOLOGY AND QUALITY OF ESTIMATES

This section describes the methodology for determining:

- Industry statistics
- VOC emissions
- Processes for controlling VOC emissions
- Cost of controlling VOC emissions
- Economic impact of emission control

for tank truck gasoline loading terminals in Mecklenburg County.

An overall assessment of the quality of the estimates is detailed in the latter part of this section.

13.1.1 Industry Statistics

Industry statistics on tank truck gasoline loading terminals were obtained from several sources. All data were converted to a base year, 1977, based on the following specific methodologies:

- The number of establishments and the annual gasoline throughput for 1977 were obtained from the North Carolina Department of Natural Resources and Community Development (DNRCD).

- The number of employees in 1977 was derived by determining the number of employees per establishment in 1977.

- Sales, in dollars, of motor gasoline for 1977 were estimated by multiplying the number of gallons of gasoline sold from terminals in 1977 by the national dealer tankwagon price in 1977 (42.5¢/gallon), which was also reported in the National Petroleum News Fact Book, 1978.

13.1.2 VOC Emissions

VOC emissions for tank truck loading terminals were obtained from the North Carolina DNRCD.

13.1.3 Processes for Controlling VOC Emissions

Processes for controlling VOC emissions for tank truck gasoline loading terminals are described in Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals, EPA-450/2-77-026. These data provide the alternatives available for controlling VOC emissions from terminals. Several studies of VOC emission control were also analyzed in detail. Interviews with petroleum trade associations, terminal operators and vapor control equipment manufacturers were conducted to ascertain the most likely types of control processes which would be used in terminals in Mecklenburg County. The specific studies analyzed were: Demonstration of Reduced Hydrocarbon Emissions from Gasoline Loading Terminals, PB-243 363; Systems and Costs to Control Hydrocarbon Emissions from Stationary Sources, PB-236 921; and The Economic Impact of Vapor Control in the Bulk Storage Industry, draft report to U.S. EPA by Arthur D. Little.

The alternative types of vapor control equipment likely to be applied to tank truck gasoline loading terminals were analyzed. Model plants reflecting each control alternative were defined and each type of control alternative used was applied to the number of tank truck gasoline loading terminals in the state. The methodology for the cost analysis of VOC emissions control is described in the following paragraphs.

13.1.4 Cost of Vapor Control Systems

The costs of vapor control systems were developed by:

- Determining the alternative types of control systems likely to be used
- Estimating the probable use of each type of control system
- Defining systems components
- Developing installed capital costs for systems components
- Aggregating installed capital costs for each alternative control system
- Defining two model terminals based on throughput levels

- Developing costs of the alternative control systems for the two model terminals including:
  - Installed capital cost
  - Direct operating costs
  - Annualized capital charges
  - Gasoline credit
  - Net annualized cost
- Assigning model terminal costs to terminals in Mecklenburg County
- Aggregating costs to the total industry in Mecklenburg County.

Costs are determined from analyses of the RACT guidelines and from interviews with petroleum marketers' associations, terminal operators and vapor control equipment manufacturers.

13.1.5 Economic Impact

The economic impacts were determined by analyzing the lead time requirements needed to implement RACT; assessing the feasibility of instituting RACT controls in terms of capital availability and equipment availability; comparing the direct costs of RACT control to various state economic indicators; and assessing the secondary effects on market structure, employment and productivity as a result of implementing RACT controls in Mecklenburg County.

13.1.6 Quality of Estimates

Several sources of information were utilized in assessing the emissions, cost and economic impact of implementing RACT controls on gasoline terminals in Mecklenburg County. A rating scheme is presented in this section to indicate the quality of the data available for use in this study. A rating of "A" indicates hard data (i.e., data that are published for the base year); "B" indicates data that were extrapolated from hard data; and "C" indicates data that were not available in secondary literature and were estimated based on interviews, analyses of previous studies and best engineering judgment. Exhibit 13-1, on the following page, rates each study output listed and the overall quality of the data.

Exhibit 13-1
U.S. Environmental Protection Agency
DATA QUALITY

Study Outputs	A Hard Data	B Extrapolated Data	C Estimated Data
Industry statistics	•		
Emissions	•		
Cost of emissions control		•	
Statewide costs of emissions			•
Economic impact			•
Overall quality of data		•	

Source: Booz, Allen & Hamilton Inc.

13.2 INDUSTRY STATISTICS

Industry characteristics, statistics and business trends for tank truck gasoline loading terminals in Mecklenburg County are presented in this section. The discussion includes a description of the number of facilities and their characteristics, a comparison of the size of the gasoline terminal industry to state economic indicators, a historical characterization and description of the industry and an assessment of future industry patterns. Data in this section form the basis for assessing the impact on this industry of implementing RACT on tank truck gasoline loading terminals in Mecklenburg County.

13.2.1 Size of the Industry

There were 14 tank truck gasoline loading terminals, as of 1977, in Mecklenburg County. Industry sales were estimated to be $616 million, with an annual gasoline throughput of 1.45 billion gallons. The estimated number of employees involved in the terminal operation in the county in 1977 was 350. The sources of this information are identified in Exhibit 13-2, on the following page.

13.2.2 Comparison of the Industry to Selected State Economy Indicators

Employees in the tank truck gasoline loading terminal industry represent 0.32 percent of the wholesale trade employment in North Carolina. The value of gasoline sold from terminals represented approximately 2.9 percent of the total value of wholesale trade in North Carolina in 1977.

13.2.3 Characterization of the Industry

Tank truck gasoline loading terminals are the primary distribution point in the petroleum product marketing network as shown in Exhibit 13-3, following Exhibit 13-2. Terminals receive gasoline from refineries by pipeline, tanker or barge.

Most gasoline terminals load all of the petroleum product they receive into truck transports at the terminals' loading racks. These truck transports usually have storage capacities, between 8,000 and 9,000, and deliver gasoline to service stations and bulk gasoline plants for further distribution.

Exhibit 13-2
U.S. Environmental Protection Agency
INDUSTRY STATISTICS FOR BULK TERMINALS
IN MECKLENBURG COUNTY

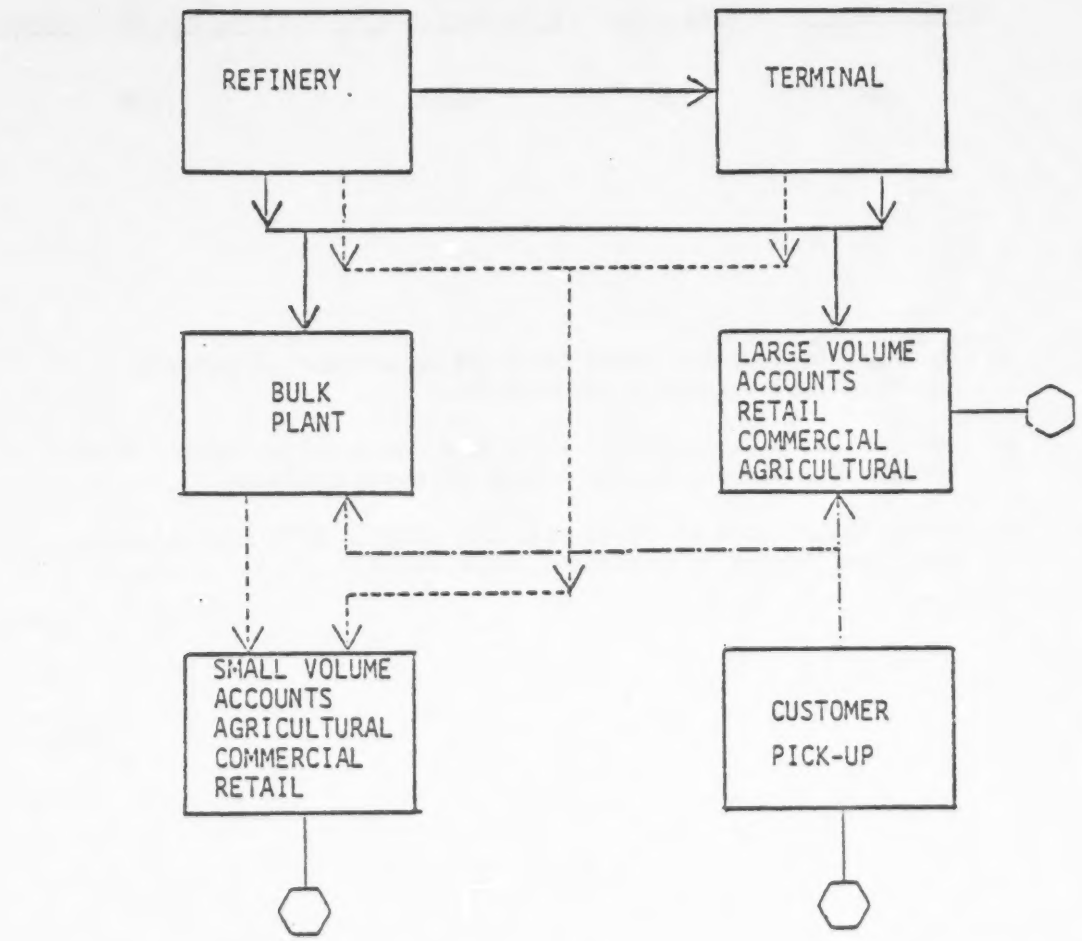
Number of Establishments	Number of Employees	Sales ($ Million, 1977)	Gasoline Throughput (Billions of Gallons)
14[a]	350[b]	616[c]	1.45[a]

a. Data provided by the North Carolina Department of Natural Resources and Community Development.

b. Booz, Allen & Hamilton Inc. estimate based on the ratio of the number of employees to the number of establishments.

c. Number of gallons of motor gasoline sold in 1977 multiplied by the national dealer tankwagon price in 1977 (42.51¢/gallon).

Exhibit 13-3
U.S. Environmental Protection Agency
GASOLINE DISTRIBUTION NETWORK



Source: Economic Analysis of Va Recovery Systems on Small Bulk Plants, EPA 240/1-77 013, September 1976, p. 3-2.

Over two-thirds of the gasoline terminals in the United States are owned by major oil companies and refinery marketers. The remaining gasoline terminals are owned by independents. The major oil companies and regional refiners own most of the large gasoline terminals and a small number of the small gasoline terminals.

Petroleum companies began to consider gasoline terminals as separate profit centers, about ten years ago. Terminals are now expected to recover all operating expenses as well as to provide an acceptable return on capital. Since terminals are now treated as profit centers, petroleum marketers have closed many uneconomic and marginal facilities throughout the country. Some marketers have withdrawn from selected regions of the country as part of their overall corporate strategy. Gasoline terminals in these markets are being consolidated, sold or closed.

Gasoline terminals are generally located near refineries, pipelines and large metropolitan areas. The daily throughput ranges from 20,000 gallons per day to over 600,000 gallons per day.

13.3 THE TECHNICAL SITUATION IN THE INDUSTRY

This section presents information on tank truck gasoline loading terminal operations, estimated VOC emissions from terminal operations in Mecklenburg County, the extent of current control in use, the requirements of vapor control required by RACT and the likely RACT alternatives which may be used for controlling VOC emissions from gasoline terminals in Mecklenburg County.

13.3.1 Tank Truck Gasoline Loading Terminal Operations

Tank truck gasoline loading terminals are the primary distribution facilities which receive gasoline from piplines, tankers and barges; store it in above-ground storage tanks; and subsequently dispense it via tank trucks to bulk gasoline plants and service stations. Terminal facilities and operations are described in detail in Hydrocarbon Control Strategies for Gasoline Marketing Operations.

13.3.2 Emissions and Current Controls

The 1975 VOC emissions from 14 tank truck gasoline loading terminals in Mecklenburg County are 3,048 tons. Based on the data provided by the North Carolina DNRCD, virtually all gasoline terminals in Mecklenburg County have floating roof tanks, and they employ top submerged or bottom filling of storage tanks and outgoing tank trucks.

13.3.3 RACT Guidelines

The RACT guidelines for VOC emission control from tank truck gasoline loading terminals require:

- Top submerged or bottom fill of gasoline storage tanks and outgoing tank trucks
- Vapor collection from trailer-transport truck loading and vapor recovery or thermal oxidation of collected vapors
- Proper operation and maintenance of equipment.

Exhibit 13-4, on the following page, summarizes the RACT guidelines for VOC emissions control from tank truck gasoline loading terminals.

13.3.4 Alternative Vapor Control Methods

There are two alternative methods to control vapor loss from tank truck gasoline loading terminals:

- Vapor recovery using one of the following techniques
  - Adsorption/absorption (AA)
  - Compression refrigeration absorption (CRA)
  - Refrigeration (RF)
- Thermal oxidation (OX)

Each type of vapor control method is briefly described below.

13.3.4.1 Vapor Recovery

Of the three vapor techniques mentioned above, adsorption/absorption and refrigeration are most likely to be used in Mecklenburg County because they are more cost effective than the compression refrigeration absorption technique.

In the adsorption/absorption method, vapors from tank truck loading operations are collected and directed to one of two activated carbon beds. Vapors are condensed into pores in the carbon. These vapors are then regenerated by applying a vacuum over the bed. Cold gasoline is then circulated in a separator and the hot vapors are absorbed into the cold gasoline. This process has recently been marketed and is becoming competitive with the refrigeration system described below. It has been reported that less maintenance is required for this type of vapor recovery system than for the other types.

In the compression refrigeration absorption method, vapors from tank truck loading operations are collected in a vapor holder. The pressure is increased in the holder, thus causing vapors to condense. Further condensation is then achieved by mixing chilled gasoline and vapors under pressure and the vapors are absorbed into the gasoline.

Exhibit 13-4
U.S. Environmental Protection Agency
VOC EMISSION CONTROL TECHNOLOGY FO
TANK TRUCK GASOLINE LOADING TERMINA S

Facilities Affected	Sources of Emissions	RACT Control Guidelines
Tank truck terminals with daily throughput of greater than 76,000 liters (20,000 gallons) of gasoline	Filling tank trucks and breathing and working losses from storage tanks	Top submerge or bottom fill tank truck and employ one of the following vapor control systems: - Adsorption/ Absorption - Refrigeration - Compression Refrigeration Absorption - Thermal Oxidation
	Leakage	Maintenance of areas that may leak

Source: U.S. Environmental Protection Agency

This system is becoming less popular than the more recently developed refrigeration system described below and it is not expected that this type of system will be used in Mecklenburg County.

The refrigeration technique relies on the condensation of gasoline vapors by refrigeration at atmospheric pressure. Vapors displaced from tank truck loading operations enter a horizontal fin-tube condenser where they are cooled to a temperature of about -40°F and condensed. Because vapors are treated as they are vented from tank trucks, no vapor holder is required. Condensate is withdrawn from the condenser and the remaining air containing only a small amount of hydrocarbons is vented to the atmosphere. Because of the competition from the AA system, refrigeration systems are priced the same as the AA systems despite higher costs.

13.3.4.2 Thermal Oxidation (OX)

Thermal oxidation or incineration involves combustion of the collected gasoline vapors. Because of fire hazards associated with the combustion, this method is not likely to be used for vapor control in Mecklenburg County.

13.4 COST AND HYDROCARBON REDUCTION BENEFIT EVALUATIONS FOR THE MOST LIKELY RACT ALTERNATIVES

This section first presents the costs of control for two model terminals which are representative of the terminals in Mecklenburg County. These costs are then extrapolated to the countywide terminals.

13.4.1 Costs for Two Model Tank Truck Gasoline Loading Terminals

The characteristics of two model terminals that represent the terminals in Mecklenburg County are defined in Exhibit 13-5, on the following page. The terminals in the county are projected to use either an adsorption/absorption (AA) or a refrigeration (RF) control system.

The cost of control systems for the two model terminals include:

- Installed capital cost, which includes the cost of:
  - Equipment ($120,000 for Model Terminal A and $155,000 for Model Terminal B, for both vapor control systems)
  - Installation (equal to equipment cost)
  - Modification of account truck ($3,000 per truck)
- Annual direct operating costs, which include electricity, maintenance, operating labor and carbon replacement costs. Maintenance costs for the adsorption/absorption system are slightly lower than those for refrigeration
- Annualized capital charges which include costs for depreciation, interest, taxes and insurance and are estimated to be 21 percent of the installed capital cost
- Net annualized costs, which are the sum of the capital charges and direct operating costs.

The estimated costs to equip each model terminal with the two types of vapor control systems are summarized in Exhibit 13-6, following Exhibit 13-5.

Exhibit 13-5
U.S. Environmental Protection Agency
DEFINITION OF MODEL TANK
TRUCK GASOLINE LOADING TERMINALS

Tank Truck Gasoline Loading Terminal Characteristics	Model Terminal A	Model Terminal B
Throughput	250,000 gallons/day	500,000 gallons/day
Loading racks	1	1
Storage tanks	3	3
Tank trucks	6	15
Compartments per account truck	4	4
Vapor control systems	Adsorption/Absorption (AA) or Refrigeration (RF)	Adsorption/Absorption (AA) or Refrigeration (RF)

Source: Booz, Allen & Hamilton Inc.

Exhibit 13-6
U.S. Environmental Protection Agency
ESTIMATED COST OF VOC CONTROL
FOR MODEL TANK TRUCK
GASOLINE LOADING TERMINALS

Cost of Control	Model Terminal A Type of Control AA[1]	Model Terminal A Type of Control RF[2]	Model Terminal B Type of Control AA	Model Terminal B Type of Control RF
Installed capital cost	$258,000	$258,000	$355,000	$355,000
Annual direct operating costs				
. Electricity	3,900	9,900	7,800	19,800
. Maintenance	10,800	13,200	13,950	17,050
. Operating Labor	1,500	1,500	1,500	1,500
. Carbon replacement	2,400	-	4,700	-
Subtotal (Annual direct operating costs)	18,600	24,600	27,950	38,350
Annualized capital charges	54,180	54,180	74,440	74,550
Net annualized cost (not including gasoline credit)	72,780	78,780	102,500	112,900

1. Adsorption/absorption

2. Refrigeration

Source: Booz, Allen & Hamilton Inc.

It should be noted that these costs do not include gasoline credit which will be taken into account when the costs are projected to the countywide industry.

13.4.2 Projection of Control Systems Costs to the Countywide Industry

Based on the throughput of 14 tank truck gasoline loading terminals in Mecklenburg County, it is estimated that 12 terminals can be represented by model terminal A and the remaining two by model terminal B. In each case, one-half of the terminals are likely to use the adsorption/absorption vapor recovery system, whereas the other half are likely to use the refrigeration system to comply with the RACT guidelines.

Using the above information and the model terminals cost from Exhibit 13-6, the total installed capital cost to the terminals in Mecklenburg County is estimated to be $3.8 million. The direct annual operating costs are estimated to be $325,000. The annual gasoline credit is estimated at $315,000, which includes the emissions reduction at the terminals only. The annualized cost per ton of emissions controlled at terminals is estimated to be $295 per ton. These findings are summarized in Exhibit 13-7, on the following page.

Exhibit 13-7
U.S. Environmental Protection Agenc
COSTS OF VAPOR CONTROL SYSTEMS FOR
TANK TRUCK GASOLINE LOADING
TERMINALS IN MECKLENBURG COUNT

Characteristic/Cost Item	Data
Number of terminals	14
Total annual throughput (billions of gallons)	1.45
Uncontrolled emissions (tons/year)	3,048
Emissions reduction from terminals (tons/year)	2,743
Installed capital cost ($ million, 1977)	3.80
Direct annual operating costs ($ million, 1977)	0.325
Annualized capital charges ($ million, 1977)	0.80
Annual gasoline credit[a] ($ million, 1977)	0.315
Net annualized cost ($ million, 1977)	0.81
Annualized cost per ton of emissions reduced, (terminal emissions only) ($ per ton)	295

[a] This includes emissions recovered from terminal operations only.

Source: Booz, Allen & Hamilton Inc.

13.5 DIRECT ECONOMIC IMPLICATIONS

This section presents the direct economic implications of implementing RACT controls to the countywide industry, including availability of equipment and capital; feasibility of the control technology; and comparison with selected state economic indicators.

13.5.1 RACT Timing

RACT is assumed to be implemented by May 1, 1982. This implies that tank truck gasoline loading terminals operators must have vapor control equipment installed and operating within the next three years. The timing requirements of RACT impose several requirements on terminal operators including:

- Determining appropriate vapor control system
- Raising capital to purchase equipment
- Acquiring the necessary vapor control equipment
- Installing and testing vapor control equipment to insure that the system complies with RACT.

The sections which follow discuss the feasibility and the economic implications of implementing RACT within the required timeframe.

13.5.2 Feasibility Issues

Several tank truck gasoline loading terminals operators in the United States have successfully implemented vapor control systems. State adoption of RACT regulations will generate a new demand for vapor control systems. It is expected that sufficient leadtime is available to meet the increased demand of vapor recovery equipment.

It has been reported during industry interviews that terminal operators have access to capital to purchase vapor control equipment, and that terminals will not cease operations because of the cost of implementing RACT.

13.6 SELECTED SECONDARY ECONOMIC IMPACTS

Implementing the RACT guidelines for gasoline loading terminals in Mecklenburg County is not likely to have an impact on employment and gasoline market structure in the county.

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Exhibit 13-8, on the following page, presents a summary of the findings of this chapter.

Exhibit 13-8
U.S. Environmental Protection Agency
SUMMARY OF DIRECT ECONOMIC IMPLICATIONS OF IMPLEMENTING RACT FOR TANK TRUCK GASOLINE LOADING TERMINALS IN MECKLENBURG COUNTY

Current Situation	Discussion
Number of potentially affected facilities	14
Indication of relative importance of industrial section to state economy	1977 industry sales were $616 million. The estimated annual throughput was 1.45 billion gallons
Current industry technology trends	New terminals are currently being designed with vapor recovery equipment
1977 VOC actual emissions	3,048 tons per year
Industry preferred method of VOC control to meet RACT guidelines.	Submerge or bottom fill and vapor recovery

Affected Areas in Meeting RACT	Discussion
Capital investment (countywide)	$3.8 million
Annualized cost (countywide)	$0.81 million (approximately) 0.12 percent of value of shipment)
Price	Assuming a direct cost passthrough-$0.0005 per gallon
Energy	Assuming full recovery of gasoline-net savings of 19,200 barrels annually from terminal emissions
Productivity	No major impact
Employment	No direct impact
Market structure	No direct impact
VOC emission after control	305 tons per year
Cost effectiveness of control	$295 annualized cost/annual ton of VOC reduction from terminals assuming no gasoline credit from vapors potentially returned from bulk gasoline plants and gasoline service stations

Source: Booz, Allen & Hamilton Inc.

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